United States Department of Agriculture

Animal and Plant Health Inspection Service

Plant Protection and Quarantine

Program Aid Number 1395

Biological Control

Spreading the Benefits

Introducing Beneficial Agents

Damage from weeds and insect pests can be minimized by taking advantage of their natural enemies. From man's viewpoint, predatory beetles, aggressive parasites, and deadly disease organisms are considered beneficial agents if they confine their attacks to pests.

Enlisting beneficial agents in pest control makes especially good sense in North America, where many farm pests are immigrants that left their natural enemies behind in the old country. Therefore, the U.S. Department of Agriculture has organized a biological control program in its Animal and Plant Health Inspection Service to spread beneficial agents. APHIS and its cooperators rear them in large numbers, store and ship them with care, release them in infested fields, and regularly monitor them to be sure they become established.

In the late 1880s, an Australian lady beetle, the vedalia beetle, was used to control an infestation of cottony cushion scale in California citrus groves. This represents the first occasion in which the U.S. Department of Agriculture was successful in controlling a plant pest by finding, importing, and releasing a beneficial agent.

Early History

Beneficial agents first were put to broad, practical use in the United States in the 1880's. At that time, California citrus groves were being devastated by an exotic insect, the cottony-cushion scale. A USDA scout working in Australia found the vedalia beetle feeding on the scale insect. The beetle, part of the lady beetle family, was successfully introduced into California and other citrus-growing regions and has kept the scale insect from causing economic damage ever since. This represents a century of achievement for organized biological control.

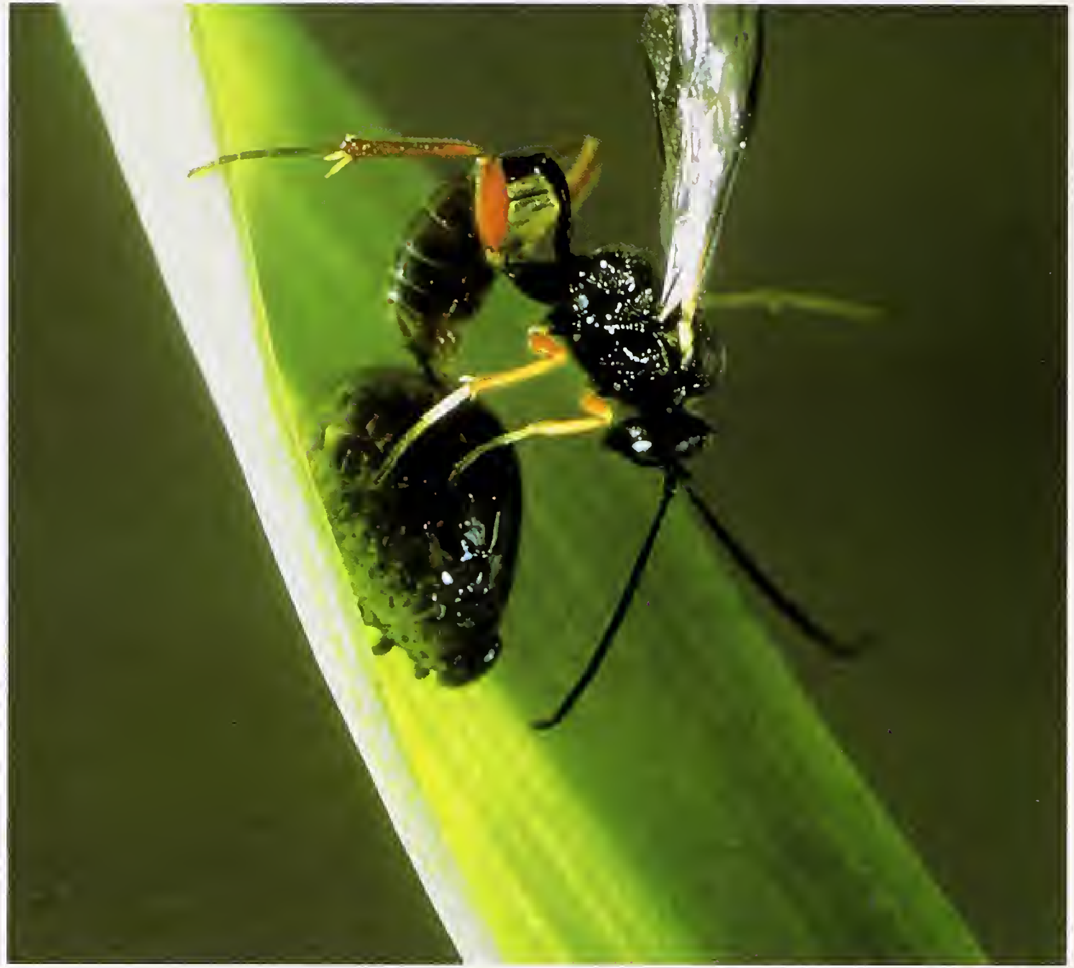
Other explorers have gone overseas from time to time to find, study, import, and evaluate beneficial agents. Several of these agents were used effectively, but after World War II, biological control was eclipsed by the advent of agricultural chemicals. Increasingly, however,

unrestricted use of agricultural chemicals has run into problems that can be avoided with biological control. For instance, pest control based on beneficial agents avoids the problem of pests becoming resistant to chemicals; and beneficial agents don't damage the environment by leaving residues.

Broad-Scale Biological Control

APHIS recently used biological control effectively in fights against new pests invading the country. For example, the cereal leaf beetle invaded the United States in 1962 and soon started causing serious damage to fields of small grain. In the beginning, Federal and State officials fought back with chemicals, but they soon realized that they could not eradicate the pest this way. They decided to adopt biological control instead, using four species of parasitic wasps that attack the pest's larvae and eggs.

APHIS spread the parasites from Wisconsin and Missouri east to New England and Maryland, saving farmers $14 million per year once the parasites were established. The total cost of the project also was about $14 million, allowing expenses to be recovered many times over.



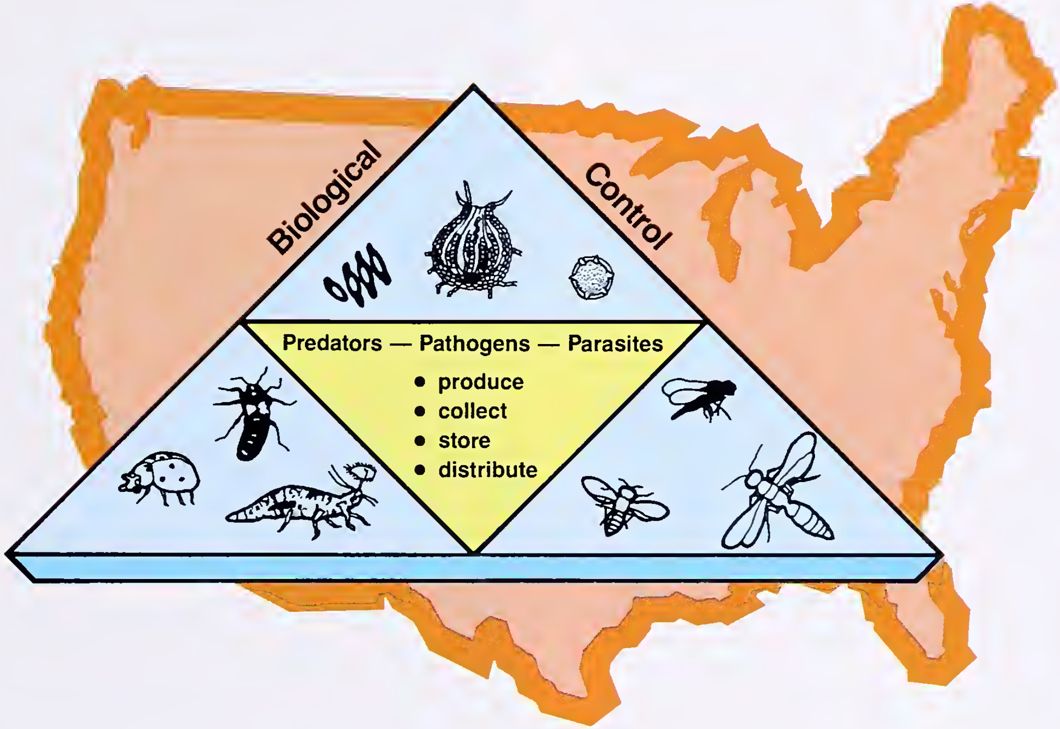
An imported stingless wasp attacks a cereal leaf beetle larva by inserting wasp eggs into its body. After hatch, wasp larvae will kill the beetle, a potentially costly pest of small grains.

Current Program

The campaign against the cereal leaf beetle showed that modern biological control techniques could be used effectively against today's immigrant pests. Therefore, APHIS officials decided to organize a long-term biological control program to spread beneficial agents in large numbers, at the right time, and over large areas.

A technical review group, with members from inside and outside USDA, advises APHIS on promising target pests for biological control. They target a pest if it causes widespread problems and if a known beneficial agent (or a combination of different beneficial agents) can minimize the damage.

APHIS concentrates on situations in which a promising biological control technique can be moved relatively quickly from limited use or experimental trials to broad, nationwide application. To achieve this goal, APHIS relies on extensive cooperation from other USDA agencies, such as the Agricultural Research Service, the Economic Research Service, and the Extension Service. Success also depends on help from State agencies, agricultural colleges, and industry groups.



APHIS-directed biological control projects adopt beneficial agents that have proven their merit in experimental trials. APHIS uses its field force and established contacts with cooperators to distribute these beneficial agents in large numbers, at the right time, and over large areas.

Predators

Predators, along with parasites and pathogens, make up the three classes of beneficial agents used for biological control. Predators are hunters. Each predator feeds on and quickly kills multiple individuals of a target pest.

Lady beetles, also known as lady bugs, are widely recognized predators. APHIS is strengthening the forces of native American lady beetles with a foreign relative, the sevenspotted lady beetle.

The project is directed against aphids, or plant lice, which draw sap from plants, killing them or stunting their growth. Under suitable weather conditions, aphids can swiftly reproduce until they reach incredibly high numbers.

Fortunately, the sevenspotted lady beetle is a match for aphids. A single beetle can consume as many as 5,000 aphids as it progresses through life as a hungry larva and then as an even hungrier adult. Farmers have relied on this beetle to control aphids on vegetables in France, cotton in China, alfalfa in Germany, and fruit orchards in England.

The sevenspotted lady beetle started a permanent colony in New Jersey in 1973, but it spread slowly. To help the newcomer along, the biological control

The larva (shown above) and adult lady beetle feed on aphids and keep this pest down. A single sevenspotted lady beetle, slated for wide distribution in the United States, can consume as many as 5,000 aphids in a lifetime.

technial review group recommended in 1984 that APHIS should systematically spread the beetle to other parts of the United States, with emphasis on States west of the Mississippi River.

The recommendation has triggered many activities. Farm plots are selected to grow and harvest large numbers of sevenspotted lady beetles. Equipment is assembled to collect and sort them quickly. Maps are marked to show areas where they already are established and to indicate points where they should be released. Teams are organized to introduce the beetles to new areas and give them a good start. Surveyors monitor their progress in colonizing new territories. Many States already have reported that the sevenspotted lady beetle has taken up permanent residence.

Parasites

Parasites operate with a one-on-one approach. Each parasite attacks only one individual of a target pest. Most parasites used in biological control projects are technically called "parasitoids," because the end result of their attack is death.

Parasites can be used not only against insects, but also against weeds. For example, a small parasitic fly from

A small fly from Europe has been enlisted to help control knapweed, a rangeland pest. Feeding by the seed-head fly's larvae reduces the production of weed seed.

Europe was enlisted to help control knapweed, a rangeland pest in the American West. This fly lays its eggs in the seed head of knapweed plants. After the eggs hatch, feeding by the larvae interferes with the normal development of knapweed seeds.

State officials started distributing the seed-head fly in 1975. Pest control workers spread the fly by making bouquets of infested knapweed seed heads and tying them to fenceposts in new areas. This procedure worked, but not fast enough. Knapweed expansion continually outran efforts to spread the fly.

In 1984, the biological control technical review group recommended that APHIS develop improved techniques, equipment, and personnel to better colonize the seed-head fly. That project is underway, and APHIS expects that the fly and other promising beneficial agents gradually will reduce knapweed numbers until they no longer do serious harm.

Pathogens

Pathogens act against target weeds or insect pests by causing disease. The resulting infection weakens or kills the pest.

For instance, there is a type of fungus that specifically attacks rush skele-

Tiny but effective, disease producing organisms can help control plant pests, such as rush skeletonweed. Greatly magnified and shown in cross section, structures of an infectious rust fungus appear yellow and dark blue on the surface of a leaf of rush skeletonweed.

tonweed. The weed, which infested western rangelands in 1938, earlier earned a poor reputation in Australia. Chemical pesticides and improved cultural practices failed to control it there, and Australian scientists went to the weed's home range in France to look for beneficial agents. They brought back the fungus along with two other natural enemies: a midge and a mite.

Biological control with these beneficial agents worked well in Australia, with most of the credit going to the fungus. In an area near the capital of Canberra, the number of rush skeletonweeds per square yard dropped from about 230 plants in 1971 to 2 plants in 1976. APHIS is laying plans to duplicate these results with a coordinated project in the infested American West.

Laboratory Support

APHIS has operated a biological control laboratory in Niles, Mich., since 1966. Recently a new laboratory was built at Mission, Tex., with 12,000 square feet under roof plus greenhouses and field nurseries. Rooms are specially lighted and ventilated and can maintain a variety of environmental conditions to properly handle and rear beneficial agents.

The laboratories support field work in several ways. They produce diets for rearing large numbers of insects needed for biological control projects. They work out collection and storage methods and develop distribution equipment and techniques. They decide where to release beneficial agents and how to evaluate the results. And they coordinate all aspects of a biological control project.

APHIS also has a facility in Bozeman, Mont., to coordinate its several rangeland weed control projects. In addition, APHIS operates methods development centers that adapt equipment to collect and sort insects, develop and refine artificial rearing diets, and design containers to hold beneficial agents during storage and distribution.

Benefits to Agriculture

The campaign against the alfalfa weevil dramatizes how farmers increasingly save time and money with biological control. The weevil became established in U.S. alfalfa fields in 1905 and eventually was robbing up to a half billion dollars from the pockets of American farmers each year.

In 1959, scientists in USDA's Agricultural Research Service (ARS) started an experiment to see if biological control could stop this damage. The re-

The biological campaign against alfalfa weevils has featured six different species of imported stingless wasps. Some specialize in attacking larvae (shown above); others attack adult weevils.

searchers worked with tiny stingless wasps from Europe, which lay their eggs inside weevil larvae or adults. After hatch, wasp larvae gradually kill the weevils.

ARS distributed the parasitic wasps in 11 Northeastern States between 1959 and 1979. Farmers responded by

reducing their use of chemical insecticides by 73 percent on the average, and many stopped spraying altogether. The reduced spraying still saves these farmers about $8 million per year, while ARS spent only about $1 million on the 10-year experiment.

APHIS Contribution

At that point, APHIS was ready to take on the job of spreading the parasitic wasps on an organized basis to the rest of the United States. APHIS biological control workers quickly built up production until they were releasing about 3 million wasps per year at a cost of about a half million dollars per year.

The benefits already have outstripped the expenses. APHIS surveyors sampled a small number of infested fields in 13 States where the parasites had been released for 4 years or more. They found that farmers reduced insecticide applications for weevil control by 5.4 percent, representing an average savings of about 38 cents per acre. Since these States grow an estimated 12 million acres of alfalfa, the total savings in those early years could add up to as much as $4.4 million per year. And, of course, the benefits keep increasing as the parasitic wasps become more widespread.

A stingless wasp attacks a Mexican bean beetle larva by inserting wasp eggs. Developing wasp larvae feed on the beetle until all that's left is a "mummy," an empty shell.

Full benefits from alfalfa weevil parasites may take up to 10 years to develop. Other beneficial agents take less time—some, in fact, do a good job of pest control the first year they are spread. If time is needed for beneficial agents to settle in, APHIS doesn't wait. Other biological control projects are started while some or all of the maintenance work needed for newly established colonies is carried out by cooperators. This already had happened in biological control projects against the Mexican bean beetle, the cereal leaf beetle, the silverleaf nightshade weed, and the citrus whitefly.

Biological control doesn't promise to control every insect pest or weed, and it doesn't necessarily eliminate all need for pesticides. Yet, biological control has made its mark. Under the right circumstances, beneficial agents employed on a large scale, can control pests effectively, at relatively low cost, and at no risk to man, animals, and the environment.

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If you believe you have been discriminated against because of any of these factors, write to the Secretary of Agriculture, attention APHIS Administrator, Room 312-E, 14th and Independence Avenue, S.W., Washington, DC 20250.

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